Evidence snapshot: cost and cost-effectiveness of 3rd generation IRS (3GIRS)

Indoor residual spraying (IRS) for malaria control is highly effective but may be limited by insecticide resistance. Third-generation indoor residual spraying (3GIRS) products† with long-lasting formulations that are effective against pyrethroid-resistant mosquitoes have been introduced, but there is limited evidence on their cost-effectiveness. The Next Generation IRS project (NgenIRS) evaluated the cost and cost-effectivness of 3GIRS in the sub-Saharan African malaria control context.

The mean cost per person targeted was **5.33 USD (95% CI: 4.18–6.47)**. The meta-analysis of effect estimates indicates an **IRR of 0.67 (95% CI: 0.50–0.91)** (Figure 1). The cost per case averted ranged from 3.20 US dollars in Ghana to 78.85 US dollars in Zambia. Results of the cost and cost-effectiveness studies are synthesized and presented in the Table. Country-specific and global probabilistic sensitivity analyses (Figure 2 and 3) show that 3GIRS is an effective intervention—despite significant heterogeneity—and may be an attractive intervention to policymakers depending on willingness to pay.

The results suggest that according to World Health Organization standards, and despite significant variability in cost and effectiveness, **3GIRS is expected to be cost-effective or highly cost-effective** in many contexts across sub-Saharan Africa when deployed in addition to current malaria-control interventions, including universal coverage with standard pyrethroid-only long-lasting insecticidal bednets.

Several factors contribute to the total cost of an IRS program. While the cost of active ingredient (AI) is one of the most significant cost drivers in nearly all programs, the AI contributes typically 20% to 40% of the total cost of an IRS program in these settings. As such, changes in AI price can impact the total program cost substantially. Sensitivity analysis indicates that malaria burden and case fatality rate are important drivers of these findings.‡

Table. Results of cost and cost-effectiveness analyses.

	Program	Insecticide product	Target dose	Expected m^2 per structure	Expected persons per structure	Cost per person targeted	IRR estimate (95% CI)	Cost per case averted	Cost per DALY averted
Ghana	AIRS/VectorLink (2017–2018)	Actellic®300CS	1 g/m^2	54.4	2.7	5.21 USD	0.60 (0.36–1.00)	3.20 USD	48.00 USD
	AGAMal (2017–2018)‡	Actellic®300CS	1 g/m^2	40.0	1.1	5.42 USD	N/A	N/A	N/A
Mali	AIRS/VectorLink	Actellic®300CS	1 g/m^2	90.0	3.6	7.76 USD	0.68 (0.52–0.89)	6.76 USD	102.00 USD
Mozambique	AIRS/VectorLink	Actellic®300CS	1 g/m^2	132.0	3.9	4.68 USD	N/A	N/A	N/A
	NgenIRS CRT	Actellic®300CS	1 g/m^2	132.0	3.9	4.68 USD	0.78 (0.77–0.79)	34.44 USD	Pending
Uganda	Abt bilateral	Actellic®300CS	1 g/m^2	101.0	3.5	5.53 USD	0.53 (0.43–0.66)	41.25 USD	625.00 USD
Zambia	AIRS/VectorLink	Actellic®300CS	1 g/m^2	66.5	4.7	3.35 USD	0.88 (0.82–0.95)	78.85 USD	1,194.83 USD

‡AGAMal's expected m^2 and expected persons are per room rather than for full structure or all sleeping places.

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Figure 1. Meta-analysis of effect estimates of IRS versus no IRS from observational studies in NgenIRS countries.

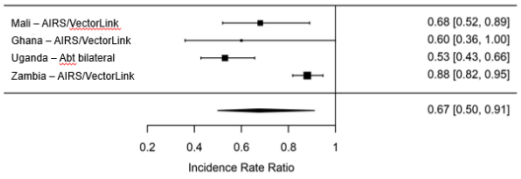


Figure 2. Global probabilistic sensitivity analysis results showing incremental cost-effectiveness ratio estimates (ICERs) for varied levels of baseline incidence.

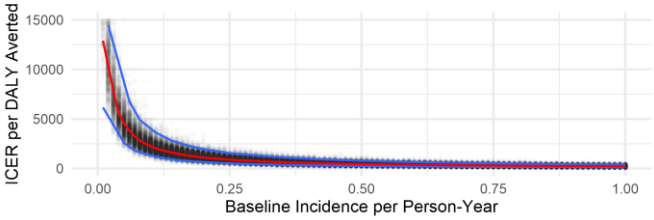
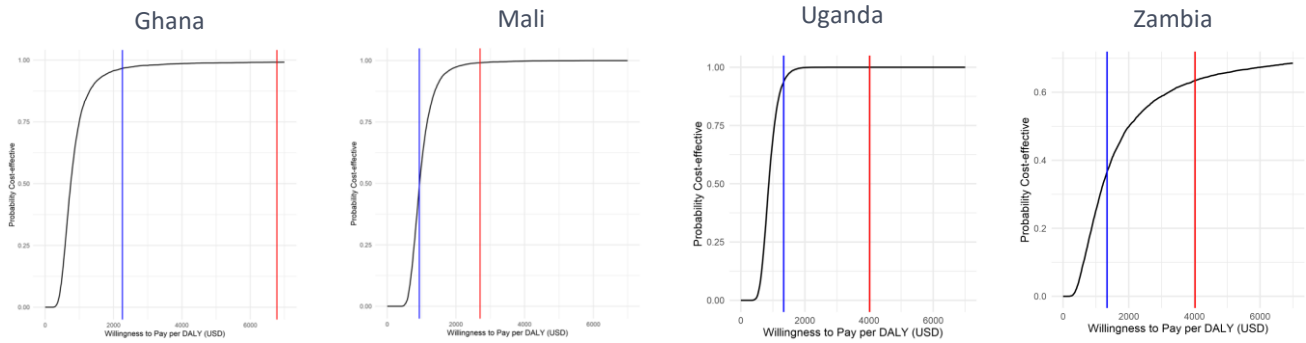


Figure 3. Cost-effectiveness acceptability curves for DALYs averted using 3GIRS in Ghana, Mali, Uganda, and Zambia with standard WHO cost-effective (red) and highly cost-effective (blue) thresholds.



Methods:

Evidence of effectiveness and cost was collected in five sub-Saharan countries: Ghana, Mali, Mozambique, Uganda, and Zambia. **Costs:** Cost data collection was targeted to collect the costs of operation for one year of IRS with a 3GIRS chemical using a bottom-up approach* to represent the cost for one year of 3GIRS with one spray round per year. **Effects:** Effectiveness is presented in terms of an incidence rate ratio (IRR) comparing 3GIRS to a situation with the standard malaria-control interventions in place,† including pyrethroid-only-based long-lasting insecticidal bednets. **Meta-analysis:** In order to derive unified information and uncertainty around cost, a meta-analytic approach estimated unit costs by calculating both the mean and standard deviation of the measured unit cost. We also estimated the parameters of a log-normal and gamma distribution that captured the uncertainty in unit costs. Effectiveness results were summarized as an IRR and 95% confidence intervals (CIs) (as well as standard errors); these were compiled across each setting and pooled using a DerSimonian-Laird random-effects model meta-analytic approach. **Sensitivity analysis:** Probabilistic sensitivity analysis was conducted for each study setting, as well as across all study settings, and was based on the results of the meta-analysis.

AGAMal = AngloGold Ashanti (Ghana) Malaria Control Ltd.; AIRS = US President's Malaria Initiative Africa Indoor Residual Spraying Project; CI = confidence interval; CRT = cluster-randomized control trial; CS = capsule suspension; DALY = disability-adjusted life year; IRR = incidence rate ratio; IRS = indoor residual spraying; N/A = not applicable; NgenIRS = Next Generation IRS project; USD = US dollar; WG = water-dispersible granules.

†Deaths and disability-adjusted life years (DALYs) averted were calculated by using a simple set of assumptions about the proportion of cases seeking treatment, the case fatality rate among malaria cases, and the age distribution of malaria deaths.

†3rd generation IRS products are effective against pyrethroid-resistant vectors and have a residual efficacy of at least 6 months.

*All annuitization were assumed at a 3% discount rate. All costs were converted to 2017 US dollars (USD) by first converting them from the recorded currency to USD using an annual average exchange rate and then converting them to 2017 USD, where necessary, by adjusting for inflation using the US gross domestic product deflator.

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